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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

February 24, 2003

Marlene H. Dortch, Esquire
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Written *Ex Parte* Communication, ET Docket No. 98-153

Dear Ms. Dortch:

On behalf of Multispectral Solutions, Inc., attached is an *ex parte* communication for filing in the above-reference docket.

Respectfully submitted,

Raymond G. Bender, Jr.
Counsel for Multispectral Solutions, Inc

RGB/vll
Enclosui-e
cc (w/o cnc.): Chairman Michael Powell
Commissioner Kathleen Q. Abernathy
Commissioner Michael J. Copps
Commissioner Kevin J. Martin
Commissioner Jonathan S. Adelstein
Ed Thoinas, Chief, OET
Julius P. Knapp, Deputy Chief; OET
Bruce A. Fmnca, Deputy Chief, OET
Bruce Romano, Associate Chief(Legal), OET
Michael J. Marcus, Associate Chief (Technology), OET
Lisa A. Gaisford, Chief of Staff, OET
Alan J. Scrime. Chief, Pollicy and Rules Division
Karen Racklcy, Chief, Technical Rules Branch
John A. Reed, Senior Engineer, Technical Rules Branch
Ron Chase, Senior Engineer. Technical Analysis Branch
Michael Gallagher, NTIA
Fred Wentland, NTlA
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February 24, 2003

Mr. Ed Thomas
Chief, Office of Engineering and Technology
Federal Communications Commission
445 12th Street, SW, Room 7-C155
Washington, DC 20554

Re: Written *Ex Parte* Presentation; ET Docket No. 98-153

Dear Mr. Thomas:

On behalf of Multispectral Solutions, Inc. ("MSSI"), we are transmitting herewith a written *ex parte* communication in the above-reference docket in response to an *ex parte* presentation submitted in this proceeding on February 6, 2003, by XtremeSpectrum, Inc. The attached MSSI comments will lead to a more accurate and complete record in this proceeding

Two copies of this letter are being submitted to the Secretary of the Commission. We note that this proceeding previously was removed from the FCC's meeting agenda and therefore is no longer subject to the Commission's Sunshine rules.

Should any questions arise with regard to this matter, kindly communicate with the undersigned

Very truly yours,

Raymond G. Bender, Jr.
Counsel for Multispectral Solutions, Inc.

RGB/vll
Enclosure
cc (w/enc.): Marlene H. Dortch, Esquire
Chairman Michael Powell
Commissioner Kathleen Q. Abernathy
Commissioner Michael J. Copps
Commissioner Kevin J. Martin
Commissioner Jonathan S. Adelstein
Julius P. Knapp, Deputy Chief, OET
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Ed Drocella, NTIA

MSSI Response to Xtreme Spectrum, Inc. 6 February 2003 *Ex Parte* Submission

In its February 6, 2003 *ex* parte submission to ET Docket 98-153, XtremeSpectrum, Inc. ("Xtreme") stated:

> *"MSSI (a) says UWB systems with a high pulse repetition frequency (PRF) are more interfering than those with a low PRF[1]; and (b) criticizes high-PRF bi-phase modulated systems (such as XtremeSpectrum's) as inadequately tested for interference effects.[2]"*

In its response to (a) above, Xtreme argues that

> *"Harm to the detector in a victim receiver is proportional to the peak signal in the resolution bandwidth (RBW) of the victim receiver. A high-PRF signal minimizes this peak to the lowest possible extent in all victim receiver architectures. This is true because a sufficiently high PRF places essentially all victim receivers into the category where the UWB signal appears as noise, characterized by PRF>5*RBW."*

These comments indicate a lack of understanding of the properties of random noise.

Indeed, by the Central Limit Theorem[3], under rather mild conditions one can show that the output of a linear filter to a high PRF stream of UWB impulses approximates a Gaussian random process.[4] (Of course, this assumes that spectral lines have been totally eliminated.) And, of course, some linear filtering typically precedes the detector stages in most, if not all, victim receivers.

However, it is straightforward to show[5,6,7] that the resultant noise power, or variance, at the output of a linear filter grows proportionally with the UWB rate. Indeed, for the wideband excitation of a narrower band filter, one can demonstrate that the received noise variance σ^2 is given by the relationship

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[1] Response to Opposition to Petition for Reconsideration of Multispectral Solutions, Inc. (at 3d page, unnumbered) (filed Aug. 2, 200)l Petition for Reconsideration of Multispectral Solutions, Inc. at 9-11 (filed June 14, 2002).

[2] Petition for Reconsideration of Multispectral Solutions, Inc. at 13 (filed June 14, 2002).

[3] Chung, K.L., *A Course in Probability Theory*, Academic Press, 2001, Chapter 7 "Central Limit Theorem and its Ramifications".

[4] Fontana, R.J., "An Insight into UWB Interference from a Shot Noise Perspective," *2002 IEEE Conference on Ultra Wideband Systems and Technologies*, Baltimore, MD, May 2002.

[5] ibid.

[6] Papoulis, A., *Probability, Random Variables, and Stochastic Processes*, McGraw-Hill, New York, 1965, Chapter 10 (cf. Campbell's theorem).

[7] Feller, W., *An Introduction to Probability Theory and Its Applications*, Wiley, 1971, Chapter VI, "Processes with Independent Increements."

where R is the UWB pulse repetition frequency, τ is the UWB pulse width, P_{pk} is the UWB peak power (per pulse), B_{NB} is the bandwidth of the narrowband victim receiver and Bp is the bandwidth of the UWB transmission.[8]

From well-known results[9,10], the envelope of a narrowband Gaussian process has a Rayleigh probability density function given by the expression

$$f_v(v) = \begin{cases} \frac{v}{\sigma^2}\exp\left(-\frac{v^2}{2\sigma^2}\right) & \text{for } v \geq 0 \\ 0 & \text{elsewhere} \end{cases}$$

Thus, the probability that the envelope of the resultant output noise exceeds some threshold T is given by the integral

$$\text{Prob}(\text{envelope} > T) = \int_T^\infty \frac{v}{\sigma^2}\exp\left(-\frac{v^2}{2\sigma^2}\right) dv$$

$$= \exp\left(-\frac{T^2}{2\sigma^2}\right) \Rightarrow 1 \quad \text{as } \sigma^2 \Rightarrow \infty$$

That is, for *any* given amplitude threshold T, *no matter **how** large*, the probability that the amplitude of the noise generated by a high PRF UWB signal exceeds T tends to 1 (i.e., 100%) as the PRF gets larger and larger. **In other words, extremely high peak fluctuations occur with interference from a high PRF UWB emitter.**

Xtreme has erroneously concluded that, since the interference from a high PRF UWB signal resembles noise, then all must be well. Unfortunately, this is precisely the problem – the interference *does* look like noise, A WHOLE LOT OF NOISE!

Xtreme then proceeds to use its flawed argument about the advantages of noise to argue (b) that "no further study is needed" for high-PRF bi-phase modulated systems. However, given the potential (as shown above) for high-PRF systems to create very large amplitude fluctuations in a

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[8] Padgett, J., *Coexistence of UWB and Legacy Narrowband Systems*, Discussion Draft for Contract MDA972-02-C-0056, *Networking in the Extreme*, Defense Advanced Research Projects Agency, Telcordia Technologies, 12 February 2003.

[9] Davenport, W., *Probability and Random Processes*, McGraw-Hill, NY 1970, Chapter 14, "The Gaussian Process".

[10] Middleton, D., *Introduction to Statistical Communication Theory*, Peninsula Publishing, Los Altos, CA, 1987, Chapter 9, "Processes Derived from the Normal".

victim receiver; and the fact that no studies of the effects of high-PRF bi-phase modulated systems have been admitted into the record; MSSI reasserts its conclusion that such systems are not well enough understood to permit their use in restricted bands of operation.

Respectfully submitted,

/s/ Robert J. Fontana, Ph.D.
President